

CMFRI Special Publication

Number 2



MARICULTURE RESEARCH AND DEVELOPMENTAL ACTIVITIES



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Cover: A raft for mussel culture
moored in the open sea
off Kozhikode.

PREFACE

In India 'Sea farming' or 'Mariculture' is a concept of recent origin as compared to inland, freshwater fish culture. Mariculture including coastal aquaculture along the edge of the sea is not practised in India at present, except on a very limited scale in central Kerala and West Bengal where culture of marine prawns and fishes are undertaken in estuarine and brackishwater fields, and in some places adjacent to the sea.

The increasing demand for protein food and highly fluctuating marine fish catches, which in general are showing a declining trend, have in recent years created a global awareness of the need to farm cultivable marine organisms in suitable environment in the inshore seas and adjacent brackish waters. Besides augmenting fish production, mariculture could also play a vital role in improving the income of fishermen as well as rural economy, in providing employment, and in better use of derelict and under-utilised water areas available all along the edge of the sea. It is possible to practice mariculture as a large-scale industry or as full or part-time avocation by even an individual family unit of fishermen/farmers.

In India, the export-oriented marine fisheries industry, which is expected to realise over Rs. 2,000 million in foreign exchange in 1977, has as its mainstay the export of prawns and prawn products. The estimation and assessment of prawn resources in our inshore waters indicate that the fishery has stabilised in some areas where increased effort will not result in increased catches. This and the need for diversification, utilisation and augmentation of resources have led the Central Marine Fisheries Research Institute to intensify researches on mariculture including coastal aquaculture. The Institute has taken a lead in formulating research and development programmes in

several priority and time-bound mariculture projects during the past five years and greatly intensified these efforts during the last couple of years.

As a result of these short-time investigations, the Institute has developed indigenous techniques for the culture of marine prawns, fishes, mussels, edible oysters, pearl oysters and pearls and seaweeds. Besides, the Institute's work has revealed the vast potentials of this sector and made it possible to spread an interest among the coastal fishermen and the entrepreneurs in the industry. By evolving suitable teaching, training and demonstration programmes, the transfer of technology at different levels, to scientists, technical personnel and fishermen farmers, is being undertaken. The Institute envisages to further intensify its research and developmental activities so that an organised industry of mariculture operations is established in the country ushering in rapid coastal rural development.

This publication, second in its series, gives briefly the various researches and developmental activities taken up by the Institute in the field of mariculture, and intends to serve as an information base to the reader. It does not provide details of research achievements nor does it give the full results of investigations. These details will, however, be published in a series of Bulletins to be brought out in future.

MARICULTURE RESEARCH AND DEVELOPMENTAL ACTIVITIES AT THE CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

The Central Marine Fisheries Research Institute was established in February 1947 by the Ministry of Agriculture and Irrigation. It came under the control of the Indian Council of Agricultural Research (ICAR) in October 1967. The Headquarters of the Institute is at Cochin, Kerala State. The Institute at present has one Regional Centre, thirteen Research Centres and twentyseven Field Centres.

The main *functions* of the Institute are, (i) to estimate the catches of marine fishes and other animals from the seas around India (ii) to conduct research on marine fisheries resources in order to step up their production to the maximum possible extent (iii) to locate new fishing grounds (iv) to conduct environmental studies in relation to fisheries (v) to develop techniques for the commercial culture of suitable species of marine and brackishwater animals and plants for augmenting fish production and (vi) to recommend measures for rational exploitation of the various resources.

The scientific work of the Institute is *organised* under the Fishery Resources Assessment, Fishery Biology, Crustacean Fisheries, Molluscan Fisheries, and Fisheries Environmental Divisions. The Institute has a good reference library, well-equipped laboratories and small research vessels for the collection of biological and environmental data.

The Institute has 901 staff members; of these 497 belong to scientific and technical categories. The budget provision of the Institute is 17.4 million rupees for the current year.

Major *activities* of the Institute include estimation of specieswise, seasonwise and statewise marine-fish production as well as on an all-India basis; studies on the effect of fishing on fish stocks and on the fluctuations in the major fisheries; biological investigations on all the marine fishes of commercial importance and the assessment of their resources; marine biological and oceanographical studies in relation to fisheries; survey on the resources of the economically important algae; mark-recovery experiments on oil sardine, mackerel, catfishes and prawns; collection, compilation and storing of data on various aspects of fisheries; researches on the culture of selected species of fishes, crustaceans, molluscs and seaweeds and training and extension service to spread the technology at different levels. Covering these activities, the Institute undertakes 43 well-defined research projects.

Major *achievements* of the Institute are (i) year-to-year estimation of catch statistics of the exploited marine fisheries resources (ii) wealth of information on the biology and fishery characteristics of all the commercially important fishes (iii) extensive data on the standing crop of plankton, factors that influence its fluctuation, extent of primary production and on the hydrographical and oceanographical features of the inshore and offshore waters (iv) a synoptic picture of the fisheries of India in space and time in the fishing grounds of up to 40-metre depth zone (v) data on the number of fishing villages, fisher population, crafts and gears employed in the fisheries and (vi) development of indigenous techniques of mariculture of fin fishes, prawns, lobsters, crabs, mussels, pearl oysters, pearls, edible oysters and seaweeds.

The Institute has been *recognised* by the Inter-University Board of India as a Centre to carry out research leading to M.Sc., Ph.D and D.Sc. degrees. The Universities of Bombay, Dharwar, Karnataka, Calicut, Cochin, Kerala, Madurai, Andhra, Utkal, Rajasthan, Pilani, Banaras, Aligarh, and Punjab have also recognised the Institute for research in marine science leading to the Doctoral Degree.

The Institute is publishing the 'Indian Journal of Fisheries' since 1954. Besides this, it brings out Bulletins, Special Publications, Krishi Vigyan Patrika (Mariculture series) and Newsletters. The Headquarters of the Marine Biological Association of India is also located here. Over 1440 scientific papers, 27 Bulletins on special scientific topics and occasional special publications have so far been published by the Institute.

MARICULTURE ACTIVITIES

The Institute has been taking an active interest in mariculture since its inception. The earlier investigations were mainly directed to obtain the basic information on the biology of the cultivable species and on the environment in which they live. Increasing awareness of the importance of mariculture in augmenting fish production and improving rural economy, has, in recent years, provided greater emphasis and thrust on mariculture research. The various activities of the Institute in this field and the progress made so far are briefly summarised below.

Although a variety of marine organisms suitable for culture are available, the current investigations are mostly concentrated on the following in view of their greater economic importance.

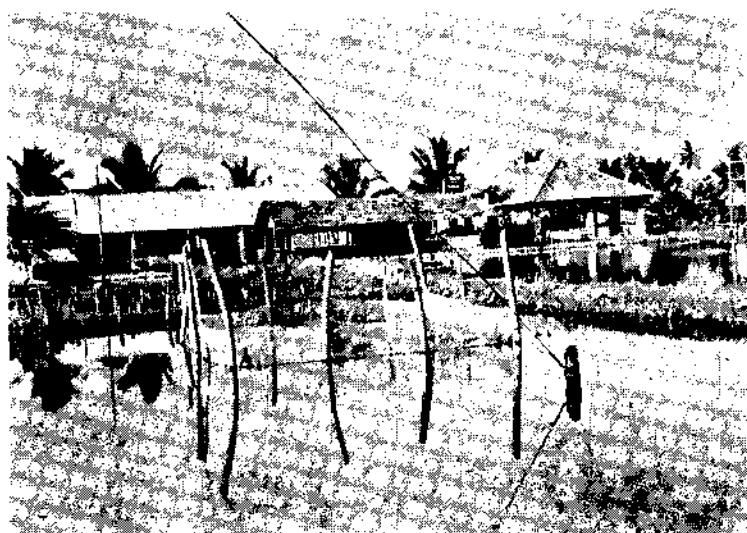
1. Prawns
2. Lobsters
3. Crabs
4. Mussels
5. Pearl oyster and pearls
6. Edible oysters
7. Clams and cockles
8. Fin fishes
9. Seaweeds

Researches on polyculture of compatible species are also being carried out.

CULTURE OF MARINE PRAWNS

Centres of activity: Researches on the culture of marine prawns are conducted at the field laboratories at Narakkal (near Cochin), Tuticorin, Mandapam Camp, Kovalam (near Madras) and Kakinada.

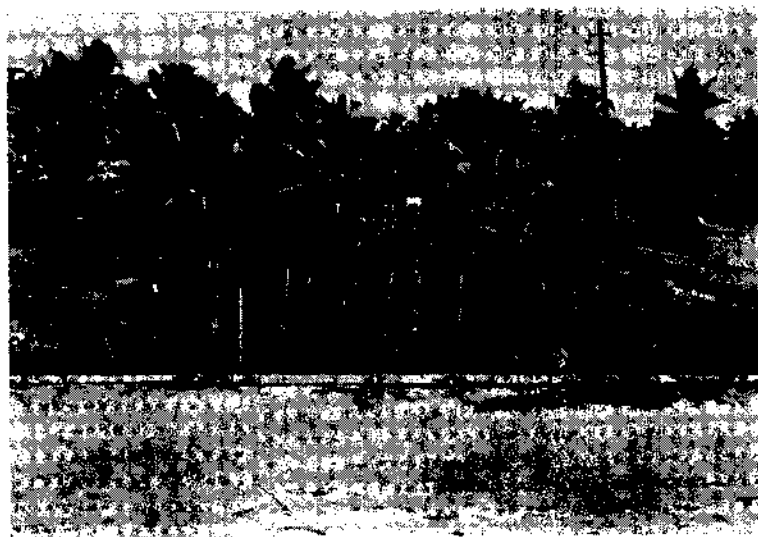
The field laboratory at Narakkal was established in 1974 under the Scheme, "Culture and propagation of marine prawns". It is the seat of main activity. The laboratory is located in a rural set up very near the seashore and is surrounded by the backwater and adjoining fields where prawns are cultivated seasonally by the traditional method. The laboratory is fairly well equipped and has a small-scale hatchery system, rearing pools, nursery, stocking and experimental ponds.



Field Laboratory at Narakkal.

Research Activities: Current investigations are directed towards perfection of techniques for large-scale culture of

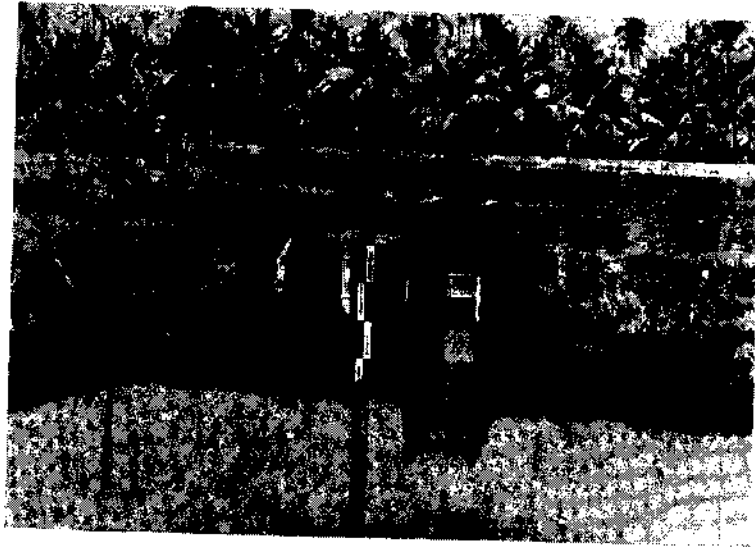
prawns on scientific and modern lines. As a result of the earlier investigations carried out at Narakkal, commercial prawns such as *Penaeus indicus*, *P. monodon*, *Metapenaeus monoceros*, *M. dobsoni*, *M. affinis* and *Parapenaeopsis styliifera* spawned



Narakkal Prawn Farm.

in the laboratory and their larvae were reared through different stages up to stocking size under controlled conditions. One of the species, *M. dobsoni*, has been successfully domesticated, as the stocked juveniles grown in the brackishwater ponds attained sexual maturity and spawned in the brackishwater medium liberating viable eggs which have been further reared through different larval stages to stocking size in the same medium. The requirements of the medium, environmental conditions and feed for the culture of different species of prawns have been studied. A good survival rate has been achieved in the rearing experiments. Techniques for mass culture of several species of diatoms, *Artemia salina*, and zooplankters which form the food of larvae and juvenile

prawns have also been developed. A survey of the seed resources in the surf region, estuaries and backwaters is being undertaken.



Inside view of one of the tanks in the Farm.

At Mandapam Camp and Tuticorin, problems of culturing prawns in pens are studied. Different stocking densities with prawns alone, and with prawns and fishes together, are tried to determine the optimum stocking rates involving different species and to obtain better yield.

In the field laboratory at Kovalam, the research endeavours to produce quality seeds of *P. indicus* and *P. semisulcatus*. Recently, success has been achieved in the breeding of *P. semisulcatus* in the laboratory and rearing of its eggs and larvae to the postlarval stage.

At Kakinada, feasibility of culture of *P. monodon* in the salt pans is studied. Preliminary experiments have indicated that *P. monodon* could be advantageously cultivated in the salt pan reservoirs along with the production of salt.

The results of field experiments carried out at different centres have indicated that (1) the prawns grow very fast in the culture fields and reach marketable size in 3-4 months (2) encouraging production could be obtained by culturing prawns in salt pans with simple management procedures (3) prawns can be cultured along with other compatible fishes such as *Chanos chanos*, mullets and *Etroplus* (4) by intensive culture a production rate between 1000-1500 kg could be realised per ha per annum.



Rearing freshly hatched larvae of prawn at Narakkal laboratory.

Developmental activities: Prawns are traditionally cultured in the low-lying areas adjoining the backwaters and in the brackishwater ponds in the states of Kerala and West Bengal. The practice involves trapping of young ones of prawns brought in by the tidal currents in the fields and culturing them for a short duration before harvesting. In Kerala two categories of fields are utilised for the purpose. In the seasonal fields, paddy is cultivated during the monsoon months (June-September)

and prawns in the other months (October-May). In the perennial fields, prawns are cultivated throughout the year. About 4500 ha are utilised at present for prawn culture in Kerala. In West Bengal, the prawns are cultured in the brackishwater ponds called "Bheris", which extend over an area of 9600 ha. The production of prawns in these fields varies from 500 to 1200 kg per ha per year.

Studies carried out by the Institute on the prevailing prawn culture activities in Kerala have revealed that the improved method involving culture of selected species of fast growing larger species such as *P. indicus* and *P. monodon* for longer duration of 3-4 months would enhance the efficiency of management and production.

To motivate industrial entrepreneurship, a demonstration of intensive culture of *P. indicus* from the seed produced at the hatcheries of the field laboratories at Narakkal and Kovalam as well as those collected from the natural source have been taken up at different private farms in the Ernakulam District. An intensive prawn-farming project is also being implemented at Narakkal.

Researches on an integrated system of cultivation of paddy and farming of prawns, fishes and livestock for bettering the economy of the fish farmers, and in turn, the rural economy, would be initiated at the field centre at Narakkal.

CULTURE OF BRACKISHWATER PRAWNS

Centre of activity: Commercially important brackishwater prawns such as *Macrobrachium rosenbergii* and *M. idella* are studied with regard to their culture prospects at Cochin.

Research activities: The pattern of distribution, seasonal abundance, growth and age, food and feeding, maturation and spawning, larval development and nursery grounds of *Macrobrachium rosenbergii* in the Pampa river system have been studied. Detailed investigations on the larval development of *M. idella* and techniques of culture of their larvae to stocking size have been undertaken. This prawn can easily be maintained

over generations as the spent female rematures and gets berried within 19 days under controlled conditions. Research programmes directed towards intensive culture of these prawns are progressing.

CULTURE OF SPINY LOBSTERS

Centre of activity: Researches on the mariculture of spiny lobsters are carried out mainly at the Research Centre of the Institute at Madras and the Regional Centre at Mandapam Camp.

Research Activities: Six species of shallow-water spiny lobsters belonging to the genus *Panulirus* occur in India. Of these, culture experiments are carried out on three species, namely, *Panulirus homarus*, *P. ornatus*, and *P. polyphagus*. The pueruli of these lobsters are collected from the inshore waters by special puerulus collectors. These are further reared in the tanks in the field laboratories, and the young lobsters, in pen enclosures erected in the inshore water. The results of initial experiments on survival and growth have indicated the possibility of obtaining marketable size from the puerulus stage in 18 months. Intensive research on the spawning of lobsters under controlled conditions and rearing of pueruli as well as on the mass culture of pueruli obtained from the natural source is progressing.

CULTURE OF CRABS

Centre of activity: Field experiments on the culture of the crab, *Scylla serrata*, are conducted in the salt pans at Veppalodai near Tuticorin.

Research activities: Seed crabs are collected from the wild source and cultured either individually in the baskets arranged in rows in the flowing waters in the field or in batches of small numbers in specially designed cages. The crabs are fed with trash fishes. The experiments have shown faster rate of growth in the cultured crabs.

CULTURE OF MUSSEL

Centres of activity: Investigations on the culture of mussels are carried out from the Research Centres at Kozhikode and Vizhinjam (Kerala) and at the Madras Research Centre.



Mussels cultured on ropes at Vizhinjam.

Research activities: The Central Marine Fisheries Research Institute initiated researches on mussel culture in 1971. Two species, namely, *Perna indica* (Brown mussel) and *Perna viridis* (Green mussel) occur in the country, the former confined to the southernmost peninsular region from Quilon to Tirunelveli Coast, while the latter distributed all along the rest of the Indian coast. Experiments conducted at Vizhinjam on the culture of brown mussel follow the "Suspended" or "Raft culture" method using ropes. The seeds of mussel are collected from the natural beds and transplanted to these ropes. The results of the experiments showed that the seed mussels of average weight of 0.29 g transplanted in September grows

to an average weight of 34.97 g in September next year. A production of 10.12 kg per metre length of rope was recorded. The annual production rate was estimated at 150 tonnes of mussels with shells, per ha, as compared to the natural production of 4 tonnes/ha.

In 1975, culture of green mussels in the open sea at Kozhikode employing the raft-culture techniques was taken up. In the experiments conducted at this centre, the seed mussel of average length 26.7 mm and live weight of 1.48 g transplanted in December grew to a size of 80 mm weighing 28.7 g in April. The production rate for a period of 5 months amounted to 235 tonnes per ha. It was also observed that the growth of mussels in the farm was very rapid (12 mm per month) as compared to those in the natural bed (8 mm per month). The results of these experiments indicated great prospects for culture of mussels in the inshore waters of our coast.

Culture of green mussels on rafts in the open sea at Kovalam near Madras is progressing.



Rafts for mussel culture at Vizhinjam.

Techniques have been developed for large-scale collection of mussel seed in the open sea.

Developmental activities: Large-scale culture of mussels to demonstrate its economic viability to the entrepreneurs is being taken up at Kozhikode. Utilising the technical know-how provided by the Institute, a pilot project is being implemented by the National Research and Development Corporation in collaboration with Fisheries Department of the Kerala State at Vizhinjam.

CULTURE OF PEARL OYSTER AND PRODUCTION OF CULTURED PEARLS

Centre of activity: Researches on the culture of pearls and pearl oyster are carried out from Tuticorin.

Research activities: The techniques for production of cultured pearls and farming of pearl oysters were developed indigenously at the Central Marine Fisheries Research Institute in 1973. Prior to this, attempts to develop the techniques had been made at two centres at Krusadai Island by the Department of Fisheries, Tamil Nadu and at Sikka by the Department of Fisheries, Gujarat, but without much success. The pearl-culture project was started in 1972 at Tuticorin with a field laboratory and open-sea oyster farm at Veppalodai near Tuticorin. Raft culture was introduced to rear the pearl oysters. The important species cultured is *Pinctada fucata*. The surgery is performed in the shore laboratory after conditioning the oysters with menthol. The operation consists of grafting a piece of mantle of the donor oyster in the gonad or hepatopancreas region of the oyster, followed by the implantation of a spherical shell-bead nucleus. The breakthrough in production of spherical pearls was achieved in July 1973.

Although cent percent success has been achieved in certain batches, the average production is about 60-70%. Multiple production of pearls in individual oysters has been achieved. The size of nucleus employed ranges from 2mm to 7mm diameter depending on the size of the oyster and the choice of

single or multiple implantation. The rate of deposition of nacre is high in the tropical sea and hence the duration of postoperative culture is considerably reduced, requiring only 3 months to 18 months for the range of 3mm to 8mm pearls for maturity. The shell beads required have been produced from the conch-shell wastes (after preparing the conch bangles), using the grinding technique. The surgical tools have been fabricated indigenously.

Since October 1973, the researches on pearl culture at Tuticorin are carried out under a collaboration scheme between the Central Marine Fisheries Research Institute and the Department of Fisheries of Tamil Nadu. Emphasis is laid on the development of pearl oyster resources to procure oysters required for the pearl culture operations. The recent surveys of the pearl banks of the Gulf of Mannar have indicated the possibility of a revival of the pearl fishery of 1961. Besides, spatfall has been observed in the coastal waters, particularly in the new artificially created harbour basin at Tuticorin. Through a Project of the Central Marine Fisheries Research Institute at Vizhinjam on the Kerala coast, the fall of pearl oyster spat in the fishing harbour under construction has been taken advantage of in raising pearl-oyster stocks.

Developmental activities: With the technical cooperation provided by the Institute, the Fisheries Department, Government of Kerala, is undertaking a pilot project on pearl culture at Vizhinjam.

CULTURE OF EDIBLE OYSTERS

Centre of activity: Major research on this subject is implemented from the Research Centre at Tuticorin.

Research activities: Experiments on the culture of edible oysters were started in the country as early as the beginning of this century. However, these were given up due to unsatisfactory progress. Nevertheless, intensive investigations on the culture of the edible oyster, *Crassostrea madrasensis* have been taken up recently at Tuticorin. The techniques of oyster

culture consist of two items, namely, collection of spat by employing different methods, and growing this spat to the adult stage by different methods such as rack culture, long-line culture, pole culture and tray culture. The different methods of capture of spat on lime-coated tiles, oyster shells strung on galvanised iron wire, empty coconut shells and rubberised coir mats are being tried. The best time of the year for spat collection varies with species, locality, fluctuations in temperature, salinity and tide. Investigations are also being carried out to develop the hatchery method of inducing the oysters to breed under controlled conditions. Experiments carried out at Tuticorin have shown encouraging results on the culture of oysters and have indicated that the growth of cultured oysters is relatively faster than in the natural beds.

A productive oyster ground with immense culture prospects has been located at Attankarai estuary in Ramnad District.

Developmental activities: A pilot project on large-scale culture of edible oyster is being taken up at Tuticorin.

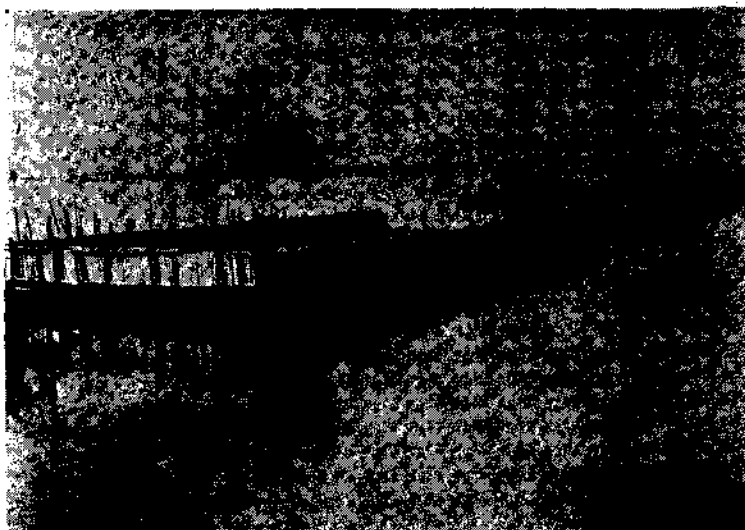
CULTURE OF CLAMS AND COCKLES

Centres of activity: Experiments on the culture of the back-water clam, *Meretrix casta*, have been initiated recently at Porto Novo in Tamil Nadu and at Buminipatnam near Waltair in Andhra Pradesh. Studies on the culture of the cockle, *Anadara granosa*, is carried out mainly from Kakinada.

Research activities: The on-going researches are mainly directed towards transplantation of clams and cockles and on off-bottom culture of cockles. It is envisaged to intensify studies on feeding and spawning biology of cultivable species and to evolve suitable techniques of culture under different soil conditions, organic detritus content of the soil, depth of the field, tidal flow, salinity and water temperature. Clam and cockle farming along with suitable fishes would also be studied.

FIN FISH CULTURE

Centres of activity: Tuticorin, Mandapam Camp, Narakkal and Mangalore are the main Centres from where investigations are undertaken on the culture of fishes such as milkfish, pearl spot, mullets, eels, and *Sillago sihama*.



Pens at Tuticorin for culture of milk fish.

Research activities: Many species of fishes such as milkfish, mullets, perches and eels are suitable for culturing in the low lying areas and impounded brackish water. The work carried out by the CMFR Institute at Tuticorin has shown that the production of milkfish in the saline lagoons and ponds can be substantially increased by resorting to proper management procedures. A production rate of 857 kg/ha was obtained.

In a recent experiment conducted at the Narakkal farm, milkfish fry (45 mm) collected from the natural source and cultivated in the ponds have registered a growth of 450 mm during a period of about 4½-5 months without any artificial feeding.

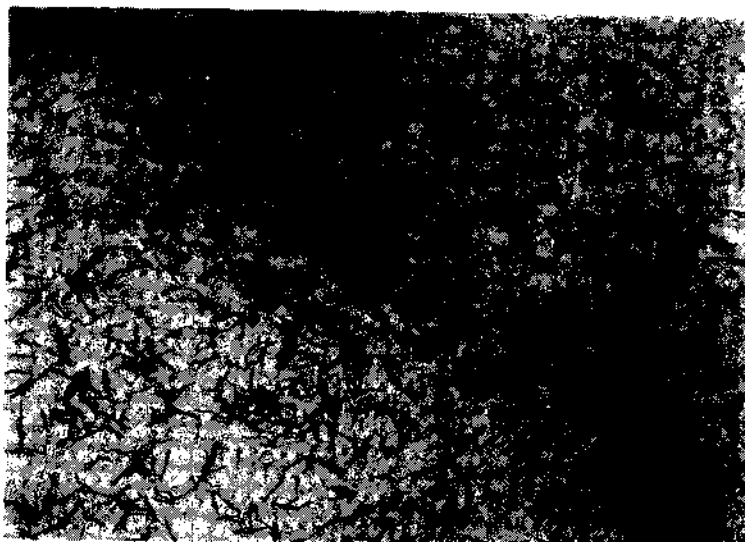


Milkfish cultured at Narakkal Ponds.

A research project on induced breeding of *Chanos chanos* has been taken up at Mandapam Camp.

The Institute has developed methods of culturing the eel, *Anguilla bicolor*, in running water. This species is abundant along the east coast and they breed in the open sea. The elvers ascend the rivers during the rainy season. Elvers are collected from suitable locations and are reared in experimental culture tanks at Mandapam Camp. This species has given a production rate of 38,000 kg/ha at the end of a period of two years. Cultivated eels have a good export market and are in great demand in countries like Japan.

Another species of fish, *Sillago sihama* is also being successfully cultured by the Research Centre at Mangalore. The species grows to about 200 mm in 7 months. Potential seed grounds have been located in the estuaries of Karnataka. Intensive investigations on the culture of the species are progressing.



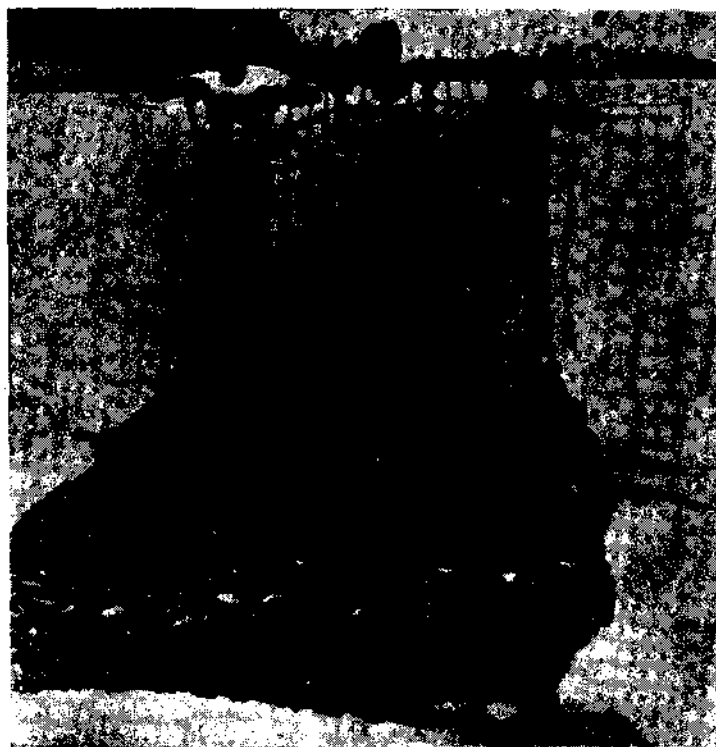
Elvers of *Anguilla bicolor*.

CULTURE OF SEAWEEDS

Centres of activity: Culture experiments on seaweeds are mainly carried out from the Regional Centre at Mandapam Camp, and the Research Centre at Tuticorin, both on the southeast coast of India.

Research activities: The cultivable seaweeds are agar-yielding plants like *Gracilaria* and *Gelidiella* species and algin-yielding plants such as species of *Sargassum* and *Turbinaria*.

Preliminary culture experiments carried out with some of the economically important seaweeds such as *Gracilaria edulis*, *G. corticata*, *Gelidiella acerosa* and *Sargassum* spp. have indicated that the species could be cultivated successfully in the coastal waters. Seaweed culture has been done by introducing fragments of the seaweed in the twists of coir ropes which are fabricated in the form of frames tied to wooden poles fixed in the coastal waters.



Gracilaria cultured on coir at Mandapam.

The experimental cultivation of *G. edulis* at Mandapam has revealed that the ideal time for planting is June-July. It has been found that three harvests could be taken in an year, the first five months after planting, the second three months later, and the third, a further two and half months later. The annual yield has been calculated as 3.5 kg of fresh seaweed per metre of rope.

In the case of *Sargassum*, a longer duration is found necessary for it to settle on artificial substrata such as concrete cylinders, after which rapid growth has been observed, and near-mature plants are seen within nine months. A growth of 37 to 52 cm from an initial height of 10 cm in *Sargassum*

cinctum has been reported within forty days. Culture experiments with *Gracilaria edulis*, has yielded 4-5 kg from an initial 1 kg of seed material, within 80 days. In *Sargassum wightii*, an average growth of 15.5 cm from an initial average height of 7.67 cm within 60 days has been obtained. *Gelidiella acerosa* has shown a growth of 3 kg from an initial 1 kg, after 77 days in the recent experiments. It is also observed that *Gracilaria edulis* cultured in Athankarai estuary showed slight bleaching than that cultured in the inshore waters. Low salinities of the estuary during rainy season have been found to be favourable for the growth of *Gracilaria edulis*.

An alternative method of culturing seaweeds is to rear the spores by keeping them on suitable substrata like corals and concrete stones on which they settle, germinate and grow into adult plants. Although this procedure lessens the utilization of the natural resources, the culture method by using fragments is easier, and the yields are quicker. The spore output in algae such as *Ulva fasciata*, *Turbinaria* spp., *Sargassum* spp., *Gracilaria* spp. and *Gelidiella* spp. has been studied. The number of spores produced in different species has been found to be abundant.

Developmental activities: A pilot project to demonstrate and test the economic viability of large-scale culture of seaweeds is being implemented at Mandapam Camp.

CULTURE OF OTHER MARINE ORGANISMS

The Institute is also studying the possibilities of culture of other marine organisms such as sponges, holothurians, marine turtles and perches. The sponge, *Spongia officinalis* var. *ceylonensis* has a wide distribution in the shallow waters of the Gulf of Mannar, Palk Bay and the Arabian Sea. It grows to 30 cm in diameter. Culture experiments on this species has indicated great prospects of its large-scale culture.

Among the echinoderms occurring in India, holothurians belonging to the families Holothuridae and Stichopodidae are commercially important. *Holothuria scabra* are widely fished,

processed and exported as *Beche-de-mer*. These are found to be suitable for culture on large scale.

Marine turtles, particularly, the green turtle, *Chelonia mydas* and the Olive Ridleys, *Lepidochelys olivacea* occur in fairly good numbers along the Tamil Nadu, Orissa and West Bengal coasts. Hawksbill turtle (*Eretmochelys imbricata*) and leatherbacks (*Dermochelys coriacea*) also occur along the southeast coast and in the Andaman and Lakshadweep islands. It is feared that large-scale fishing of turtles, collection of eggs by human and destroyal by dogs and jackals are adversely affecting their resource. In this context, farming of turtles has been suggested as a remedial measure for protecting the resource as well as for commercial harvest. The Institute in collaboration with the Madras Snake Park Trust actively participated in the collection of eggs of Olive Ridleys occurring along the Madras beach and releasing the hatchlings into the sea during 1976-77.

MASS CULTURE OF FOOD ORGANISMS

Centres of activity: Researches on the culture of food organisms required for the culture of fishes, crustaceans and molluscs at different stages are carried out at Cochin, Narakkal and in the Research Centres at Tuticorin and Madras.

Research activities

Culture of phytoplankton: The Institute has so far isolated 10 species of phytoplankters such as *Tetraselmis gracilis*, *Chlorella marina*, *Chlorella* sp. *Synchocystis salina*, *Aphanothercea* sp., *Oscillatoria salina*, *Oscillatoria* sp., *Thalassiosira subtilis*, *Navicula* sp. and *Encyonema prostratum*. They have got varying growth constants and generation time. The growth kinetics and nutrient requirements for optimum and economically viable yields of these phytoplankters have been investigated and techniques of mass culture in the laboratory as well as in the field have been developed. The harvest is taken during the exponential phase depending on the requirements arising out of larval concentration.

Culture of the brine shrimp: Considerable progress has been achieved in the culture of the brine shrimp, *Artemia salina* under laboratory conditions. Continuous mass culture of the species is being maintained in large plastic pools and fibreglass tanks. Production ranges from 500 to 1000 individuals per litre. Oviparity and ovoviviparity have been induced to obtain the dormant eggs. Techniques of collection of dormant eggs and apparatus for purification of these from the culture tanks have been evolved and perfected. Decapsulation of *Artemia* eggs is also being done in the laboratory facilitating direct feeding of prawn larvae.

Culture of marine rotifer: The marine rotifer *Trichocerca* sp., is isolated and cultured in fertilized sea water. The culture is being maintained at present at a population density of 5,000 to 10,000 individuals per litre. On-going experiments include mass culture of rotifers using different fertilizers.

Culture of zooplankters: Calanoid, cyclopoid and harpacticoid copepods are cultured in the tanks fertilized with chemical fertilizers such as potassium nitrate and potassium (dibasic) phosphate. Initial experiments have provided encouraging results on the culture of zooplankters by employing the above simple method. Detailed studies are in progress.

Developmental activities: Attempts are being made to develop systems which can yield adequate quantities of different food organisms to cope up with the requirements of large-scale seed production in hatcheries and culture operations in the field. Studies on nutrient cycling as part of pollution management are also undertaken.

ARTIFICIAL FEED FOR THE CULTURE OF PRAWNS

Centre of activity: The research project on the preparation of artificial feeds and selection of the best feed for culture operations of prawns was carried out from Cochin.

Research activities: 21 types of feeds, having varying ingredients of wheat flour, coconut cake, ground nut cake, sardine

meal, prawn meal, fish meal, tapioca powder, rice bran, supplemented with minerals and vitamins and using agar-agar as binding agent, have been prepared and feeding experiments with the postlarvae and juveniles of *M. dobsoni* and *P. indicus* conducted. The data of these experiments are being analysed to determine the suitable feed for use in large scale culture.

SURVEY RELATING TO MARICULTURE

With a view to promote and develop mariculture, and to assess its potentials, the Institute conducts special surveys such as 1) Prawn, fish and shell-fish seed resources survey 2) survey of the productivity of cultivable water areas 3) survey for identification and selection of suitable sites for mariculture and coastal aquaculture 4) survey of the mangrove swamps and 5) special survey of the Andaman and Nicobar islands.

1. *Prawn, fish and shell-fish seed resources survey*

It is well known that one of the essential prerequisites for successful culture operation is the availability of quality seed



Prawn Seed collection from surf.

of desired species. The source of supply of seed is either those occurring in the nature or those produced in the hatcheries. The seed in the natural resource is subject to wide fluctuation in abundance depending on the breeding characteristics of the species concerned and due to environmental factors. A clear understanding on the availability of seed, their grounds, and the factors influencing their abundance is, therefore, essential to advise the fish farmers and to ensure steady supply.

To investigate these aspects, the Institute initiated in 1975-76 a survey on the seed resources of cultivable species in the coastal waters of Tamil Nadu and Kerala. Valuable data have been collected under this research project and they are analysed and compiled to map out the seed resources in different regions of this coastline. It is envisaged to extend the survey to other adjacent maritime States in the current and ensuing years.

2) *Survey of the productivity of cultivable water areas*

This project has been initiated recently. In Kerala, different types of fields occur; some of them such as those located around the Vypeen Island being highly productive, while the fields situated farther from the bar mouth being relatively less productive. The project is aimed at a comprehensive study of the relative productivity of the fields in Kerala so as to advise the fish farmers on the potentials of the ground and the expected harvest.

3) *Survey for identification and selection of suitable sites for mariculture and coastal aquaculture*

With increasing awareness of the potentials of mariculture, several requests are received by the Institute about suitable sites for culture operations. To meet this demand, the Institute conducts a comprehensive survey of the cultivable water areas by a team of Scientists drawn from different disciplines. The data collected during this survey are utilised to

chart out the suitable sites for mariculture and coastal aquaculture of different species.

4) *Survey of the mangrove swamps*

Extensive mangrove forests occur in the deltas of rivers, bays, and estuaries along the east and west coasts of India and around Andaman and Nicobar islands. Mangrove swamps are highly productive and serve as nursery grounds of several cultivable species. Some of the mangrove swamps are also suitable for culture of prawns, fishes and oysters. To study the ecology of the mangrove swamps and their associated fauna and flora, the Institute commenced a survey of these areas. The mangroves occurring in the Cochin backwaters and at Tuticorin have been studied. It is proposed to extend the survey to other centres along the coast and in the Andaman Islands.

5) *Special survey of the Andaman and Nicobar Islands*

Along the coasts of Andaman group of Islands, there are several bays, inundations, creeks, swampy areas suitable for mariculture operation. A comprehensive survey to assess the potentials and to locate suitable sites for mariculture of fish, crustaceans, molluscs and seaweeds in the Island is being planned and executed. The results of the survey would help to formulate developmental plans for establishing mariculture activities on commercial scale in the Island.

OPERATIONAL RESEARCH PROJECT

The main objective of the operational research project is to improve the production, income of the small-scale fishermen in particular, and of the rural economy in general, through an innovation of blending the culture of suitable organisms in the coastal waters as an avocation, along with the normal fishing activities of the area. The activities include an initial survey of the fishing conditions of the project area including the socio-economic conditions of the fishermen as well as the fishing village, organisation of fishermen into viable units, selection and introduction of suitable species for culture, participation of fishermen|women|boys in the culture operation, training of

fishermen in the techniques of culture, assistance to harvesting and marketing, and a post-survey to study the impact of the project.

An operational research project on the above lines has been drawn up for implementation at the Kovalam fishing village near Madras. The initial survey has already been undertaken. It is proposed to introduce culture of mussels in the inshore sea by active participation of the fishermen. Similar projects are being planned at a few other selected centres.

TRAINING PROGRAMMES

Realising the importance of transfer of technology developed by the research Institute to various levels, the Institute has been organising different kinds of training courses, particularly on marine prawn and pearl culture.

To impart training to fish farmers, a Krishi Vigyan Kendra (Farm Science Centre) for Mariculture was established at Narakkal in 1976. Under this Kendra, a series of non-formal courses on marine prawn-cum-fish, mussel, seaweed and edible oyster culture are being organised. So far, two short-term courses, each of four-weeks duration on marine prawn and fish culture were successfully completed. Besides imparting training, the Kendra also aims at rural development through mariculture by extension service, consultancy, surveys and follow-up programmes.

The Institute conducted scientific courses on coastal aquaculture and in the breeding and rearing of marine prawns under the scheme of "Summer Institute" sponsored by the Indian Council of Agricultural Research for the University teachers, Research workers and scholars to update and improve their knowledge. With increasing demand for training in prawn culture, the Institute is scheduling to organise regular short-term course of 6 weeks duration and long-term course of 4 months duration for the benefit of the research workers and development officers in the maritime States and farm managers in the industry.

On pearl culture, the Institute conducts two kinds of training courses. The comprehensive training of six months duration is a Trainers Training programme while the short-term course of 4 weeks duration is intended for technicians in the specific field. These training programmes are also demand-based for the benefit of the maritime States and the industry.

EXTENSION AND CONSULTANCY SERVICE

Mariculture and coastal aquaculture to augment fish production and for rural development is a new concept among the fishermen|fish farmers in the country. To popularise this avocation and to establish a well-organised mariculture fisheries in the country, the Institute publicises its results of investigations through popular articles, special bulletins, radio talks, seminars and discussions with the fish farmers. The research results are published in scientific journals published in the country and abroad.

The consultancy service is also provided by the Institute to the fish farmers and entrepreneurs desiring to take up mariculture. While the fish farmers are exempted from any fee the organised section and the industry are charged with a nominal fee for the technical advices.

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